1975-09

An approach to point of sale system acquisition cost-benefit analysis

Fleming, James Alexander, Jr.

Monterey, California. Naval Postgraduate School

AN APPROACH TO POINT OF SALE SYSTEM ACQUISITION COST-BENEFIT ANALYSIS.

James Alexander Fleming

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

AN APPROACH TO POINT OF SALE
SYSTEM ACQUISITION COST-BENEFIT
ANALYSIS

by

James Alexander Fleming, Jr.

September 1975

Thesis Advisor: F. R. Richards

Approved for public release; distribution unlimited.

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): An Approach to Point of Sale System Acquisition Cost-Benefit Analysis	5. TYPE OF REPORT & PERIOD COVERED: Master's Thesis; September 1975
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): James Alexander Fleming, Jr.	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Naval Postgraduate School, Monterey, California 93940	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Postgraduate School, Monterey, California 93940	12. REPORT DATE: September 1975
	13. NUMBER OF PAGES: 65
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

point of sale
electronic point of sale
electronic cash register
automated supermarket
automated retailing
exchange
commissary

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Point of Sale (POS) Systems introduced into the retail and supermarket industries exemplify a change which is occurring in all data collection. Initial Department of Defense utilization of POS Systems is occurring in commissaries and exchanges, military counterparts of the supermarket and retail industries respectively. The purpose of a POS System is to automate point of sale by replacing the electro-mechanical cash register with an electronic cash register (ECR) capable of some degree of interaction with the computer.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601 |
(Page 1)

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

This thesis summarizes the diffuse literature on POS Systems through discussion of POS System development, components and configurations, and proposes a general cost-benefit model to assist in the POS System acquisition decision.

An Approach To Point of Sale System Acquisition Cost-Benefit Analysis

by

James Alexander Fleming, Jr.
Lieutenant Commander, Supply Corps, United States Navy
B.S., United States Naval Academy, 1962

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

ABSTRACT

Point of Sale (POS) Systems introduced into the retail and supermarket industries exemplify a change which is occurring in all data collection. Initial Department of Defense utilization of POS Systems is occurring in commissaries and exchanges, military counterparts of the supermarket and retail industries respectively. The purpose of a POS System is to automate the point of sale by replacing the electro-mechanical cash register with an electronic cash register (ECR) capable of some degree of interaction with the computer.

This thesis summarizes the diffuse literature on POS Systems through discussion of POS System development, components and configurations, and proposes a general cost-benefit model to assist in the POS System acquisition decision.

TABLE OF CONTENTS

I. INTRODUCTION

A profound change is taking place in retail industry operations. At the root of this change are Point of Sale (POS) Systems with which the retail industry is automating the point of sale. The use of data processing equipment is not new to retailing since it has long been used in the home offices or the backrooms of stores to analyze sales data and to assist in a broad spectrum of inventory control functions. Increasingly, within the last few years, an electronic cash register (ECR), capable of interacting with a computer, is replacing the current electromechanical cash register.

POS equipment is not cheap. The New York market research firm of Frost and Sullivan estimates that equipment worth $420 million has been installed. By 1984, it is predicted that $10 billion will have been spent. This money will be spent by both industry and government. The most obvious Department of Defense outlays will occur first in military commissaries and exchanges. As in industry, the advent of POS Systems in the military retailing environment is only the beginning.

Mr. Moses Shapiro, Chairman of the Board of General Instrument Corporation, in an address to the National Retail Merchants Association Conference on EDP stated [1]:

> "In its broadest perspective, the POS revolution is only a relatively small part of the vast change which has begun to occur in all organized human activity. Its essence is the development and application of systems and technology which enable people and institutions to operate in an information-enriched environment, containing vastly more information, more accurate information, and more timely information than ever before. The change is so great and its implications are so profound that they amount to a major societal watershed."

The revolution centers around the use of intelligent terminals. An intelligent terminal is an electronic terminal capable of collecting transaction data. An example is an ECR employed in a supermarket which collects data concerning which items are sold, the cost of each order and even how long it takes to process the order. The collection of this data results in timely analysis and reports concerning inventory, financial and personnel functions. This type of information was previously not available to management or was so untimely as to preclude it making a positive contribution to management actions.

The term Point of Sale (POS) (or synonymously EPOS for Electronic Point of Sale) is used to encompass the myriad intelligent terminal and computer interface models and applications. The system might more appropriately be called a point of transaction system in that terminal applications are found at other than sales points.

The most apparent uses of POS are the supermarket and the chain retail (variety) store. The Department of Defense has installed POS systems in some Exchanges, Commissaries and has pilot projects underway at Naval Supply Centers in Charleston and San Diego. These installations are in self-service stores which provide fast-mover retail support to ships. These stores are called SERVMARTS [2]. Other applications are in the fast food chains and in banking. Each of the applications noted varies significantly from the others relative to the number of line items and number of transactions. For example, a fast food outlet may have forty items on the menu with a large number of transactions occurring per item. A supermarket may have twenty-two thousand line items with

high item turnover. A POS system must, then, be tailored to the particular application but will always incorporate an intelligent terminal.

The banking application is obviously different from the other three mentioned. Money transmission or electronic funds transfer (EFT), a POS type system, is the banking system of the future[3]. Although it is an application of POS, EFT will not be treated extensively beyond this brief introduction.

In the banking parlance, the result of POS use is a reduced "float," or money in-transit on paper. Funds are transferred among Federal Reserve Banks by electronic means at the present time but very little banking is done by EFT at the private or consumer level [4]. The first publicized use of EFT was the installation of computer terminals by the First Federal Savings and Loan Association at two Lincoln, Nebraska, grocery stores in January 1974. Customers at the store with accounts at First Federal can make deposits, withdrawals or pay for groceries at the grocery store terminals and the need for checks is eliminated. This installation benefits both the grocery store and the financial institution as a result of less cost per transaction, added to convenience to the customer and reduced credit risk to the store. The Nebraska installation coupled with a ruling by the U. S. Comptroller of the Currency, has opened the door to a proliferation of bank terminals in any type retail outlet[5]. The ruling permitted the installation of 'intelligent' bank terminals in stores, shopping centers and service stations and ruled that these installations did not constitute branch offices of the bank. These applications of

electronic banking terminals could change the face of the banking industry.

The many possible applications of electronic terminals necessitate a variety of terminal types. The manufacture of POS systems has been undertaken by computer industry leaders such as IBM and Sperry-Univac [6]. The most successful POS system manufacturers, based on sales, are Singer (Friden) and National Cash Register (NCR), two companies which have parlayed expertise and experience in the electro-mechanical business machine arena into leadership in the electronic POS field. Two companies, General Electric and Pitney Bowes-Alpex, entered the field and left after sustaining large losses. Pitney Bowes, known for the manufacture of postage meters and little else, entered the POS system manufacturing field in 1970 by forming a joint venture with the ALPEX Computer Corporation [7 and 8]. This joint venture was a leader in the field at the time of its demise in November 1973. In three years, the venture had lost twenty-eight million dollars. This was due to both poor management and leapfrogging technology. The field is a very competitive one which is undergoing rapid expansion. According to Datapro Research Corporation, 1976 sales of POS systems to retail and supermarket chains should reach four hundred million dollars [9]. Datapro further asserts that the competitive advantage accruing to merchants with POS systems will make the systems virtually mandatory in order for any store to remain fully competitive.

Two terms, the Universal Product Code (UPC) and scanning, warrant specific discussion in relation to the roles which they

play in POS systems. Both subjects can be considered as enhancing a POS system and are described below.

A. UPC

The UPC is a bar code adopted by the grocery industry in April 1973 [10]. UPC was developed by a committee comprised of grocery industry representatives acting in concert with a consulting firm, McKinsey and Company of New York. Based on committee expertise and codes recommended by firms interested in POS, the straight line bar code which appears on most grocery products is a machine readable code and was adopted by the committee after nearly three years of deliberation. Implementation of the use of the code on grocery store items was estimated to have been 65-75% complete at the end of 1974. It should be noted that UPC was adopted only by the members of the grocery industry. Due to the physical aspects and variety of goods involved in the retail industry, UPC is not considered to be the answer for coding of general retail merchandise. These facts, coupled with a less structured and coordinated cadre in the retail industry, have resulted in delays in a single standard being adopted for retail merchandise coding. A Voluntary Retail Identification Standard (VRIS) was adopted in December 1974 by the National Retail Merchants Association (NRMA), but VRIS is not enjoying success similar to that being achieved by UPC [11]. The VRIS is an Optical Character Recognition (OCR) type of coding. OCR readers recognize a specified set of particular characters. The UPC is machine and person readable: this is accomplished by including a two part code, one part (bars) for the machine and the other (numerals) for

the person. The adoption of the UPC in the grocery industry has permitted grocery item processors and packagers to afix the UPC label prior to distribution. A label is defined as a code which is part of the item packaging or is attached by adhesive whereas a tag will be a code device which is tied to the item as a sweater price tag. A common misconception is that the UPC includes item price. The UPC contains only a manufacturer code (first five digits) and a manufacturer assigned item code (seond five digits). The coding of retail merchandise is done by the retailer and not the manufacturer, a subtle but significant difference to be subsequently discussed. The reason for item coding and the adoption of UPC and VRIS is to provide item identification that is machine readable.

B. SCANNING

The use of an intelligent terminal to capture information and directly or indirectly communicate with the computer is supplemented and enhanced by the addition of a capability of the POS system to scan. Scanning is the means by which a code (UPC, VRIS or others) is read and transmitted to the terminal. The term scanning used in relation to POS systems ranges over several different types of codes and therefore methods of reading codes. Codes vary from the punched hole tag on retail goods read by a punch tag reading ECR to UPC marked grocery store items which are scanned by either a wand attached to the ECR or a scanner which is imbedded in the checkout counter and is connected to an ECR. Both of the UPC scanners employ a low powered laser beam to read the UPC [12].

A POS system can be generalized by viewing it as a management information system (MIS). A principal component is the data

collection device which records transactions. The transactions may be sales or merely transfers of funds. The recording of the transaction when and where it occurs is the basic principle to be considered. Devices recording the transactions may be augmented by scanning capability. Further, the device may be interactive with a computer as in an ECR using price look-up (PLU). In this instance, the UPC is scanned and, based on the scan, the item price is retrieved from a file, usually disc, and appears in the ECR window and on the sales tape.

The availability of the principles, technology and hardware of POS systems can be of obvious benefit in a multitude of ways to many civilian and military organizations. Within the military, the obvious applications are the military exchanges and commissaries which differ only slightly from civilian variety stores and supermarkets in actual operation. Other applications of the POS principles and technology within the Department of Defense are being reviewed. An application that is being tested and evaluated is in a SERVMART [13]. A SERVMART as previously explained is a retail self-service store for shipboard supplies and is utilized to provide, with minimal delay, a variety of low-cost (less than $250) high demand items to the customer. A SERVMART provides one-stop shopping on a range of items, thus obviating the need for a requisition for each item [14]. Coding SERVMART items and applying a POS system will expand the transaction data available to management while enhancing customer service.

POS systems are a relatively new outgrowth of automated management information systems. Application of the point of transaction data collection principle has not yet been fully exploited

and many applications may yet evolve. The capacity and capability of existing systems is not yet fully utilized.

Installation of a POS system is not a panacea. A potential user needs to know what technology is available; what hardware or hardware combinations can be purchased or leased. To purchase the most effective system for a given application, the task to be accomplished must be well defined and quantifiable. Once the system is installed, the performance must be evaluated in order to substantiate the prior analysis which led to the decision to purchase and to preclude having the system operate ineffectively at a financial loss.

POS evolved from efforts to cut costs and widen profit margins, particularly in the supermarket business where net earnings are a relatively low 1% of sales. In order to cut costs in this or any other application, life cycle cost analysis must be accomplished.

The literature which is available concerning POS Systems is largely fragmentary and appears mostly in periodicals and technical journals. The purpose of this thesis is to present in summary form the information encompassed by the literature and to discuss this information in a cost-benefit analysis framework. The use of a simple cost-benefit model is intended to provide a focal point for the ensuing discussion of costs and benefits and an approach to deciding upon POS System acquisition in any environment. A review of POS System components and configurations will be followed by an analysis of costs, benefits and other considerations that should accompany a decision to acquire a POS System.

II. POINT-OF-SALE SYSTEMS

POS systems are tailored to the particular requirement to be satisfied. The type of industry or application dictates the components ant the configuration of components to be utilized. Military applications more closely parallel the supermarket and retail store type of POS system than that of the banking or fast food type, although the latter could be utilized in military food service in the future.

In order to best relate to military application, ensuing component and configuration discussion will be based on supermarket and retail store type applications since installations of this type exist in the military environment. Both systems to be discussed have in common the capability to handle large line-item inventories and large line-item orders per customer. While these two applications are similar, several differences do exist in areas such as the retail store's concern with seasonal and fashion changes, greater credit sales volume, and generally larger numbers of cash registers. Each of these unique aspects requires special consideration in choosing a POS system. A supermarket, on the other hand, requires a capability to handle coupons, food stamps and needs to provide uninterrupted service. The requirement for uninterrupted service can significantly alter POS system requirements for supermarkets.

Three basic configurations will be reviewed, followed by a discussion of the components which make up the POS systems. The three types to be reviewed are local, in-store and on-line [15].

A. POS SYSTEM CONFIGURATIONS

1. Local System

A local system is one in which data is collected at the point of sale by a terminal but no action beyond collection is accomplished. In this system configuration, the terminal acts as a data collection and storage device. Storage is effected on magnetic tape cartridges or cassettes for subsequent processing by a computer. The terminal is programmed to perform price extensions, tax calculations and similar actions automatically. In this type application, the terminal is a stand-alone ECR that is capable of collecting data and performing transaction related functions faster and more accurately than the conventional cash register.

2. In-Store System

An in-store system includes a controller in addition to the intelligent terminals. The controller can be either a programmable minicomputer or a hardwired processor or a combination thereof. In the local system, the terminal needed only a power source to function. In this configuration, the terminal is dependent on the controller and thus is not capable of stand-alone performance. The use of a controller expands system capabilities greatly. Added capabilities include credit verification, price look-up (PLU), management reports and inventory control. Further, data collected can be formatted, edited and compacted onto a single magnetic tape by the controller. This capability permits the transmission or transportation of a single tape, in lieu of a cartridge from each terminal, to the installations main computer. Addition of the controller also permits the utilization of

peripheral equipment such as printers, cathode ray tube (CRT) data display units and price or coded label printers.

3. On-Line System

In the on-line system, communication with the headquarters or host computer is feasible. This system is really a linking together of several in-store systems wherein the controller (minicomputer) performs not only the functions described above but also acts as the communications liaison between the terminals and the host computer. The addition of the host computer interface provides a two-way communication channel which management can utilize to transmit information to all terminals and can provide real time credit and inventory access.

4. Configuration Summary

The three configurations listed are basic outlines of systems and are, in themselves, representative of POS system levels of sophistication, ranging from the local to the real-time on-line system. The configurations encompassed a range of capabilities and costs. Costs and capabilities can obviously be expected to increase in direct proportion to each other. The specific configuration should be tailored to the need; a small variety store chain would be best served with a local system with data processing accomplished by a computer service bureau. A large national chain such as Sears, Roebuck and Co. could eventually desire on-line capability that could provide their Chicago headquarters with chain-wide data on an as required basis.

B. POS SYSTEM COMPONENTS

1. Terminal

The component which is the most visible and most important is the intelligent terminal or ECR. The ECR is the data collection device at the front end of any configuration or application. The ECR generally resembles a modernized electro-mechanical cash register in appearance but will vary significantly among applications. With the infinite POS application possibilities, the actual appearance is relatively unimportant for other than esthetic reasons but will be considered to be a cash register type terminal throughout this paper. As such, the ECR will consist of a keyboard, visual display device, printout device, internal logic and, depending on the application, some type of scanning equipment. Keyboards may be color coded for ease of operation or may even follow a sequence of lighted keys to guide the operator through each transaction. This feature is incorporated in the Singer model 925 and 'walks' the operator through the transaction by lighting the key of the next operation that should be performed. The printing device produces register tape receipts for the customer as does the electromechanical registers.

Most new receipt tapes will incorporate expanded information such as an item discription as well as its cost and will indicate information such as whether an item is taxable or not. The visual display device will provide visual feedback to both the operator and the customer regarding data input entered by scanning or by key. The capability of the terminal to operate alone is determined by the degree of internal logic incorporated. The more internal logic, the greater the terminal's stand-alone capability. Terminal cost will

also vary in direct proportion to these two aspects. A variety of label and tag readers are available and constitute the automatic data entry feature that can be utilized in lieu of keyboard entry.

2. Controller

The controller is the central repository of logic and processing capability that greatly expands terminal abilities. The controller literally controls the terminals and can provide file access for PLU or credit that isn't normally encompassed by a stand-alone terminal. The use of a controller necessitates terminal dependence which, in the event of controller failure, can neutralize the entire system. Consideration must be given to the tradeoff between system capabilities with a controller and system failure operating alternatives. The controller serves to control the terminals and such peripheral equipment as necessary, including printers, disc and tape files and CRT display units. Further, the controller acts as an interface between the terminals and the host computer.

3. Host Computer

The main office, headquarters or host computer is the last component of a POS system and, in the context of a POS system, is 'the computer' that has been serving at the headquarters or regional level prior to the advent of POS. The computer is the component of the POS system which is the final processor of the data which is collected. Here again the degree of sophistication of the system involved will dictate the means of transmission of data from terminal to computer. In a local system, terminal tapes may be collected daily and transported physically to the computer

for processing. In a more sophisticated and expensive system, the data will travel on-line via the controller.

The components and the component configurations of a POS system have been outlined in general terms. Publications exist which describe each component in detail relative to capacity, capability and cost, as well as other pertinent information such as maintainability, component compatability and a history of performance to date in other installations. Two prominent books are published by Auerbach Publishers Incorporated and Datapro Research Corporation. Both companies are analytic reference services which provide comprehensive computer technology reports on equipment, software and related EDP subjects. Either of these two books or some other is essential to the comprehension of the hardware available in POS systems.

It would be illustrative, at this juncture, to describe the situation as a single line item moves through an on-line POS system which is fully implemented and utilizing its full capabilities [16]. Assuming a retail type item, a blue widget, the initial step is receipt at a store. The widget is taken up in inventory as it is received from the warehouse or vendor. Item receipt is entered in the POS system and an automatic ticket-maker, which is also part of the system under the controller, produces a tag or label describing the widget relative to color, stock number and price. The tag or label is placed on the item and the item placed on the shelf. When the item is procured by a customer, it is taken to an ECR where the tag or label information is read by a wand or punched in by the ECR operator. The scanning by the wand has transmitted to the controller the widget

stock number, color and cost which is retained by the controller until the close of business. At the close of business, this transaction and all others from the day are transmitted to the host computer for processing, summarization and report output. On a daily basis, sales information and inventory management data is made available at a level of detail never before available. At the register, if the customer chooses to pay by credit card, the customers account number is read or keyed in and his credit standing verified. At the close of business, the widget transaction is charged to the customer's account, sales and tax information is entered in the accounting records and the sales persons commission is recorded in payroll, all automatically. Thus far, the financial implications of the transaction have been automatically accommodated by the controller and host computer.

The host computer is also utilizing the transaction data relative to an inventory management system. The sale of the widget will cause the on-hand balance of blue widgets to be decremented. If the balance of blue widgets has reached a point low enough that more should be ordered, the reorder point, the computer automatically produces a purchase order for them. While the financial and inventory aspects are being automatically entered in records, sales data are being collected, formatted and summarized for management at the local and headquarters level.

In summary, this chapter has established the outline of POS systems by describing the major components, three configurations of these components and provided insight to the functional operation of a POS system. This information and the background information of the introduction provides the basis for the more detailed system cost and benefit analysis to follow.

III. POS SYSTEM COST-BENEFIT CONCEPT

The POS system is an extension of the computer, a type of data collection and entry system. As such, it has a computer mystique which generates a feeling among potential buyers that such a system is essential to the company's on-going business well-being. Indeed, the evolution of POS has been the result of a quest to do a more effective and efficient job primarily in the retail and supermarket industries. It may ultimately prove to be an industry saviour, particularly in the grocery industry where profit margins have become extremely thin due to competition.

As a potential get-well tonic, POS technology has been heartily embraced by many companies. The quality of analysis and research that a company does prior to deciding to commit itself to a POS system will largely determine whether the company will gain or lose from the decision. Although costs have not been discussed as yet, suffice it to say that the decision by a company to enter the POS arena is a very expensive decision and must be unequivocably offset by benefits.

Therefore, it is essential that a decision to enter, or not enter, the POS system arena be accompanied by substantive analysis of the costs and benefits that will accrue as a result of installing a POS system. This is a deceptively difficult undertaking since it requires an ability to foresee, with a high degree of predictability, each cost that will be encountered for the life of the system. The predicted costs of POS may then be compared with the costs of alternative systems to accomplish the tasks

involved. The types of costs to be considered are many. The benefits to be derived from the system will accrue to not only the company making the purchase but to system operators and to customers. Benefits to other than the potential purchaser will be discussed but are not as directly relevant to the acquisition decision as are the benefits accruing to the company.

In proposing an approach to the decision of whether or not to acquire a POS system, there are several areas that will be discussed, some quantifiable and others somewhat qualitative. In other words, the approach will encompass soft as well as hard benefits. Further, there are considerations which may be either positive or negative in nature which can strongly influence a company's decision to become a POS system user, even though these considerations defy categorization as a cost of any type. A hard benefit might be the saving of a salary. A soft benefit more appropriately is characterized as a potential range of dollar savings dependent upon a decision, thus encompassing a degree of uncertainty.

Of primary concern in the cost benefit analysis for a POS system are the net returns. Net returns are the benefits minus the costs. The total costs of a POS system are determined as are the total benefits. Various alternatives are similarly evaluated and comparisons made among all the evaluations. Alternatives in the POS context might be another POS system level or an electro-mechanical system. The best alternative is chosen based on the analysis and such other considerations as are pertinent. The cost-benefit analysis is not a substitute for judgment but is an attempt

to quantify, for comparative purposes, all costs related to the alternatives being evaluated.

The costs and benefits components will be listed in the ensuing chapter followed by a discussion of other considerations.

The model which ties together all the costs involved is simplistic in nature but does provide a systematic approach to delineating costs and benefits. The excess or shortfall of benefits is represented by (all in units of dollars);

$$TB-TSC$$

Where TB = Total Benefits

TSC = Total System cost

In turn, the total system cost is derived as follows;

$$TSC = I_h + I_o + AY$$

Where I_h = Hardware investment

I_o = Other investment

A = Annual operating costs

and Y = Number of years of operation anticipated in the life cycle or comparison period

Total benefits are simply stated, albeit not simply derived, as follows;

$$TB = Y(B_h + B_s)$$

Where B_h = Hard benefits

B_s = Soft benefits

The components of each term will be explained in the next chapter. The model is designed to sum up all initial and preparatory costs, add these costs to annual operating costs and

compare this total cost with total benefits received. This comparison provides input to a decision to acquire a POS system. Total benefits should exceed total costs in order for POS System acquisition to be considered.

IV. POS SYSTEM COSTS

Costs are not easy to define. In order to compare one alternative to another, costs measured in dollars are commonly utilized because dollars are a convenient measure of costs. A cost analyst, an accountant and an economist might all view certain costs differently. For example, there are marginal, recurring, fixed, sunk and direct costs with which to contend in the literature. Since this thesis is concerned with POS Systems and not cost concepts, costs will be only loosely defined. For purposes of this thesis, a cost can best be considered as a benefit lost or more simply the cost of making a decision. For example, the cost of a new car can be defined many valid ways; in terms of a monthly payment, the sticker price, interest foregone in a savings account or loss of family goodwill because a vacation is no longer possible.

In order to concentrate directly on POS System costs and benefits, certain assumptions are considered pertinent. Consideration is given only to outright procurement and leasing options are not discussed.

A. ASSUMPTIONS

1. The system being procured will be of the on-line configuration.

2. A host or headquarters computer is available for use and does not need to be purchased, which eliminates a major cost component.

3. The available computer is compatible.

4. The installation of the system will occur in a store which has no system installed as yet but which was designed for the conventional electro-mechanical type cash register. In other words, POS systems have become a viable option at some point in time between store design and physical store completion. Briefly stated, either a POS System or electro-mechanical registers will be installed.

5. Due to many similarities, accompanied by a few but significant differences, the cost-benefit model will encompass a combined retail-grocery operation. Most of the cost principles are the same but in areas such as coding and registers, differences do exist.

Costs will be discussed in the order of hardware, other and operating. To provide a frame of reference, cost ranges will be included with each POS hardware component. Price ranges, where available, will encompass ranges of both capability and manufacturer and will primarily include Singer, NCR and IBM as a basis for the range.

B. HARDWARE INVESTMENT COSTS

$I_h = \sum I_{hi}$ where the I_{hi} represent the individual costs involved. No upper bound on the summation is set since the number of cost components will be a function of the specific system.

1. I_{h1}-Terminal Costs

The most important component of a POS system is the terminal . It should be purchased to meet the exact requirements extant at the point of sale in the purchaser's system. The number

of terminals in a POS system is the largest variable in the system in terms of possible numbers variance. Key entry as well as scanner capability for data entry is an essential consideration. In considering what scanning capability is available, the type of code involved in the business is essential; in other words, what kind of label or tag can the terminal read. The use of an on-line system in the model implies greater dependence on the system controller but some stand alone capability for emergencies should be available. If it is not, particularly in the supermarket environment, suitable backup capability must be available to permit business continuation. A credit verification capability should be an integral part of the terminal. The visual and graphic outputs of the terminal are important to consumer good will, insuring that the consumer can monitor the transaction and be provided with a readable sales slip. The total number of terminals times the price per terminal yields I_{h1}. Price range: $3,000 - $4,200.

2. I_{h2} - Scanner

The scanners is an extension of the intelligent terminal and is one of the keys to expanded data collection. Scanner technology is usually based in fiber optics and laser utilization, but also includes the reading of punched holes. The type of label or tag to be read is obviously crucial as is scanner compatibility with the terminal. Scanner range from hand-held wands to those imbedded in the supermarket checkstand which are the higher priced. Price range: $850 - $4,000.

3. I_{h3} - Controller

This is the minicomputer which will normally be under the same roof as the terminals and is the unit which 'controls'

the terminals. Three main factors effect the cost involved in controllers; the number of terminals to be controlled, system sophistication and a need for backup capability. System compatibility is obviously essential but, beyond that, the best purchase consideration is buying what is necessary over the system life to accomplish system tasks. Price range: $13,000 - $74,700.

4. I_{h4} - Terminal Peripheral Equipment

This cost component is primarily intended as a miscellaneous cost collector. The peripheral equipment, other than the scanner equipment discussed above, is an area in which purchases should be made to fill a need and to please the corporate taste. A very important point in connection with terminal peripheral equipment is that it proliferates at the same rate as terminals. Thus, the total cost for coin dispenser attachments that cost $500 will be $10,000 excluding quantity discount considerations if 20 terminals are installed. The following terminal peripheral equipment is available and is basically supermarket oriented;

stamp dispenser ($565 - $620 pair)

coin dispenser ($525 pair)

scales ($1,000 plus)

scale adapter ($225)

checkout scanner adapter ($2,250)

It is important, for example, to understand the ramifications of buying a checkout scanner at a cost of $4,000 per terminal. This is the imbedded laser scanner which reads the UPC as it is passed over a window at a speed up to 100 inches per second. The IBM laser scanner can't be operated without a scanner adapter which costs approximately $2,250. It is important to understand that

buying a POS system can be very similar to buying an automobile; there is a base price which can be augmented considerably with options and extras until the total cost far outstrips the base price. It is also important to note, as in car buying, what is included in the base price and what is not, particularly when comparing models. Peripheral equipment costs, I_{h4}, are merely the total peripheral equipment outlay in dollars.

5. I_{h5} - Data Collectors

The type of system envisioned may obviate the need for a separate data collector. In the IBM 3650 Retail Store System, the collection function is built into the store controller. In some NCR systems, this is not so and based on the number of terminals employed, a data collector must be purchased. The data collector is the device which actually records and holds the transaction for transmission to the main computer. Price range: $3,095 - $19,100.

6. I_{h6} - Output Devices, Visual

Access to the data collected by the system will be primarily by way of a printer. The printer is simply the same output device normally associated with a computer and performs that function for POS system data output. If the system is a multi-store POS system, installation of a printer at each location will be necessary both to receive information and reports from the system and to permit inquiry response. A second output device to be considered is the Cathode Ray Tube (CRT) which is a television-like screen utilized primarily to provide response to inquiries. The IBM models have unit prices as follows:

CRT Display Station - $6,700

Printer - $6,000

7. I_{h7} - Storage

Storage costs are a function of two variables; the storage requirement of the system and the amount of storage included in the controller. The number of price, credit and other files to be held in memory dictates the overall storage space requirement. It is important to note that some controllers include disc drive capacity while, in other systems, the disc drive will be a separate cost item. Storage is basically limited to disc drive because of the speed of access required. Price: $26,000

8. I_{h8} - Ticketing Unit

The ticket unit is really necessary only in a retail POS system. The reason for this being that a UPC type coding system has not been implemented. The UPC is a part of the supermarket item label. In the retail industry, the merchandise must be tagged subsequent to receipt at the store and prior to sale. This necessitates production of some type of tag (punched hole, magnetic strip) which can be automatically read at the point of sale. In other words, in order to automatically capture data at the point of sale, special tags produced by a ticket unit are necessary. The number of ticket units required depends on item volume and ticketing centralization. Price: approximately $22,000

9. I_{h9} - Communication

In this cost component is the hardware which enables machine to machine data transmission. Data communication among and between data processing equipment is facilitated by the use of modulator - demodulator units (MODEMS). MODEMS are used at each end of any communication line which is more than about 50 feet long. The MODEMS convert the digital signals to audio signals suitable

for transmission over a communications line and then reconvert them at the other end. Each terminal does not require a MODEM but locations remote from the controller, for instance, the host computer, will require MODEMS at each terminus of the communication line. The cost of establishing data communication is not insignificant but depends on too many variables to include a price range or estimate since each installation will have custom-made requirements.

C. OTHER INVESTMENT COSTS

$I_o = \sum I_{oi}$ where the I_{oi} represent the individual cost components. As in the hardware components, no specific upper limit on the summation is established. No costs estimates will be attempted since the variance among installations precludes any meaningful estimates.

1. I_{oi} - Site Preparation

Having assumed a new store without provision for a POS system, significant costs can be anticipated in this component. Site preparation could be encompassed in this overall store design phase if POS installation has been decided upon in advance. Site preparation encompasses any of the physical alteration or construction that is attendant to system installation to include data and power line installation, air conditioning due to equipment installation, and physical alteration at the point of sale to accommodate the terminals and other peripheral equipment.

2. I_{o2} - Power Supply

Additional power will probably be required, either for the equipment or air conditioning installed. The increased power

requirement in the context of a one time investment cost would be reflected in additional power lines or auxiliary generator installation. The latter could also be considered for emergency power requirements to provide for minimal operations.

3. I_{o3} - Training and Education

The manager, the operators and the consumers are all basically unfamiliar with the computer-based POS system. Operator training is an obvious cost to be incurred in order to promote effective and efficient terminal operation. While not as mechanically essential, management training will form the basis for full utilization of the system's capabilities. Perhaps the most important education involved is that of the consumer. POS systems potential to cut costs through task elimination and speed based on the computer may be severely impaired by consumers. If the consumer is not provided with sufficient knowledge to understand and accept the savings potential of PLU and elimination of individual item pricing, a portion of potential savings could be eliminated by consumer group action. Education of the consumer who is face to face with a computer system for the first time can preclude considerable negative response. Consumer education is of paramount importance and is accomplished primarily through promotional leaflets and advertising.

4. I_{o4} - System Analysis and Software

This cost component will be a direct reflection of how well the system purchaser is able to define the requirement for the system. If this is an initial consideration of POS, it is incumbent upon the potential purchaser to be able to define, in detail, what the system has to accomplish and if it has to be compatible with

existing systems. This knowledge must be translatable into software (computer programs) that will support the requirement. The source of software may be the hardware vendor, a software house, the potential purchaser's own programmers or any combination of these. Minimization of this cost component can be accomplished by thorough analysis and planning.

5. I_{o5} - Miscellaneous

Advertising, initial merchandise tagging, and transportation to inspect other installations are all one time costs that could be incurred at the outset of POS system installation. Taken individually, each might be insignificant but, when taken collectively, could be a factor.

D. OPERATING COSTS

$A = \sum A_i$ where each A_i represents a cost incurred on a continuing basis, an operating cost. In conducting a review of these anticipated costs, a period of measurement such as monthly or yearly should be utilized.

Up to this point, in a comparative cost sense, a method for deriving the costs of hardware and other cost components has been described. In the operating cost area, cost items are much more comparable. Both systems will incur personnel salary costs and, therefore, only the difference between the costs of salaries is pertinent. If a POS system incurs greater power costs than the alternative with which it is being compared, the difference is a cost of choosing the alternative and this is reflected as such. On the other hand, if fewer people are required to operate the POS system, a savings has been effected or a benefit gained and the

cost will be lodged against the alternative system. In relation to a POS system then, a cost can be viewed as a negative benefit and is established in a comparative context.

1. A_1 - Personnel

This cost component consists of the personnel costs under each system. It is important to analyze each category of personnel under each system and conclude which system will require the most people to operate it. Division of personnel costs into categories helps in comparison of similar costs. Backroom personnel, terminal operators, stock clerks and managers are among the possible categories of personnel. Comparison by categories is then effected. A POS system in a supermarket should require fewer ECR's because of ECR transaction speed and thus fewer operators would be required. In addition, personnel scheduling can be improved under a POS system. Thus, for example, terminal operator costs would be less under a POS system and would not be costs but in fact a benefit. Additional personnel would be required, however, for software maintenance under a POS system and, therefore, a continuing annual cost would be incurred.

2. A_2 - Supplies

The system costs will center around paper, labels, tags, ink, fasteners, printer ribbons and such seeming incidentals.

3. A_3 - Maintenance

Predicting maintenance costs might best be left to the hardware manufacturer from which the system is acquired. Almost all manufacturers offer maintenance contracts which include not only preventive maintenance but emergency service as well.

Obtaining the contract thus is a sort of combination planned maintenance cost plus an insurance policy against system failure costs.

4. A_4 - Leased Communication Lines

This cost is exclusively a POS system cost since data communication is the backbone and selling point of the system. The extent of leased telephone lines required will be a function of system sophistication, geography and technical data processing needs.

5. A_5 - Power

With the added equipment of a POS system, a rise in power costs is almost assured and, as in leased lines above, can be a predicted POS system cost.

The cost components above are by no means exhaustive. It would be impossible to anticipate all the costs associated with all systems. The cost components listed are intended to provide a starting point and general model framework for systematically identifying, measuring and evaluating all costs associated with the systems under consideration.

V. POS SYSTEM BENEFITS

The development of system costs on a predictive basis is not a simple task. The unbiased quantification of benefits is considerable more difficult. Many costs are accounted for on a detailed basis in a firm's accounting records. The amount of dollars committed to equipment depreciation and monthly operating costs are identifiable. Benefits, on the other hand, are reflected in lower cost and higher revenues leading to increased profits. The costs of purchasing, operating and maintaining a particular equipment can be derived, for the most part, directly from a firm's accounting records. A benefit such as the saving of a salary is most often not identified at all in an accounting sense. A benefit might be defined in an accounting sense as the absence of a cost.

In order to best quantity the anticipated benefits of a POS system, benefits will be devided into hard and soft benefits. The hard benefits are those more readily quantified. The latter type of benefit is that which is readily identified and accepted but the evaluation of its dollar impact is not easily done. Each type of hard benefit will be further sub-divided into one of the following three major categories: financial, inventory, and personnel.

The distinction between hard and soft benefits is not particularly germane to an initial decision to buy or not buy a system. At the outset, it is necessary to prove, in terms of actual hard dollars, that a savings will occur. In fact, the hard benefits alone from pilot installations have served to justify

system acquisition [17]. It is anticipated that in the long run, the real benefit will be from the so called soft benefit that is not easily quantified.

A benefit is calculated simply by comparing the cost to do a job under the POS system with the same cost under the alternative being considered. If the cost of accomplishing the task is less under POS, a benefit with a dollar value of the cost difference is derived.

A. HARD BENEFITS $B_h = B_{hf} + B_{hi} + B_{hp}$

1. Financial $B_{hf} = \sum B_{hfi}$

a. B_{hf1} - Uncollectible Accounts

Real time access to positive credit files regarding both check and credit card information will save time and more importantly money, by precluding credit authorization in risky circumstances. Incorporation of credit authorization capability reduces the cost of labor-intensive telephone credit checks [18]. The credit check aspect is normally associated with credit cards but is being extended to the type check cashing that is done by supermarkets to maintain customer goodwill. Supermarket industry experts estimate losses through bad checks amount to 10% of net earnings [19].

b. B_{hf2} - Accuracy

The batch mode of sales processing retrieves about 85 - 90% of transactions according to the Montgomery Ward Program Manager for Corporate Systems. Further, it takes time to retrieve

sales data, up to three or four days. With daily sales data availability and a 95 - 98% sales data capture, both losses and inventory can be reduced. Reduction in inventory will improve return on investment.

c. B_{hf3} - Misrings

The retail and supermarket industries operate on 3 and 1% profit margins respectively. In a $10 order in a supermarket, a $.10 under-ring negates the order's profit. With scanning and PLU, this loss can be all but eliminated.

d. B_{hf4} - Coupon Control

The handling of redeemable coupons on items is somewhat inexact. Exact counts of coupons redeemed and the correct prices are inherent in the POS system. Coupon control can lead to intelligent decisions regarding advertising methods by coding coupons utilized by local newspapers and local mailers and tracking redemption rates. The latter aspect of coupon control is, in fact, a soft benefit as contrasted with the dollar and cents accuracy aspect.

e. B_{hf5} - Security

Since each terminal can be monitored, it is virtually impossible to process a "sweetheart" order, one where the register operator 'discounts' orders for friends [20].

f. B_{hf6} - Courtesy Booth

The check cashing, question answering booth which most stores have will operate more effectively and efficiently with the check verification capability and real time cash drawer balances.

g. B_{hf7} - Cash Count

The intelligent terminal has a real time cash balance capability. This feature results in quicker ringouts at the close of business and more accurate and accessible cash balances, thus reducing cash shortages.

h. B_{hf8} - Calculation Accuracy

All item extensions, tax calculations and multiple item pricing are accomplished by the terminal, eliminating error from transactions.

2. Inventory $B_{hi} = \sum B_{hii}$

Extensive treatment of financial and personnel savings is found in most POS system savings and benefits articles. While inventory savings are recognized as being part of overall POS system benefits, precious little literary space is devoted to the savings possible in this area. Perhaps the biggest contribution a POS system makes to inventory management is the provision of real-time inventory data. The inventory position of any item is available at any point in time. A transaction is recorded as it occurs and his information can be made available to a decision maker. An inventory system in which the demands are recorded as they occur is a transactions-reporting or continuous-review system [2]. This type of system permits a decision regarding reorder as each demand occurs. Contrasted with the continuous-review system is the periodic-review system which is the more prevalent type of inventory system. In a periodic-review system, the status of the inventory is known only at the review time which might be on a weekly basis. Since demand is random in nature, the number of an item that has been sold between reviews can, at best, only be

forecast. As a result, a unit would be much more likely to run out of stock or pass the point of reordering in a periodic-review system. With the advent of POS systems, continuous-review inventory systems are a reality and the impact of randomness associated with how much has been sold can be eliminated. Replenishment orders can be automatically initiated when the on-hand level reaches a reorder point. Essentially, all randomness except that of future demand is removed from the inventory system.

Due to the paucity of treatment of inventory savings in other POS literature, it will be accorded a more in-depth treatment in this thesis with the objective of promoting fuller utilization of POS capabilities.

a. B_{hil} - Inventory Taking

An inventory is conducted in order to determine how much of a given item is physically on hand and to verify proper labelling and physical condition. Taking an inventory is costly, time consuming and may inconvenience customers. POS system transaction data capture is significantly better than current methods. Current methods include the collection of sales slips for subsequent recording or entry on cards. This system results in a 10 to 15% transaction loss. With a POS system, it is expected that transaction data loss will be well below the 5% level. With this level of accuracy, the necessity for taking physical inventories can be reduced to a bare minimum along with the attendant costs. Not to be ignored is the application of wand reading to inventory taking when a physical inventory is necessary. The use of a portable wanding unit can greatly facilitate the physical counting necessary.

b. B_{hi2} - Stock Level Investment

The basic reason for an inventory of goods in the retail and supermarket industries is to furnish goods for sale to the consumer. The goods on the shelf as well as those in the warehouse comprise the total inventory. If the supermarket industry knew exactly how much of each item could be sold, his inventory problem would consist of setting up a schedule of deliveries to meet the consumers' demand. Unfortunately, demand and such other factors as price, production schedules and availability are not so stable as to permit this type of deterministic scheduling on the part of the retailer. The retailer establishes certain levels of stocks which hopefully protects him against the vagaries of demand and helps to preclude running out of an item. Under a POS system, the fact that demand is recorded as it occurs provides management the data to insure that orders are placed at the proper time, thus reducing the risk of running out of stock. The reduction in stock level because of less risk is a direct savings of dollars. Fewer dollars are required to be 'tied up' in inventory, a very measurable savings.

c. B_{hi3} - Lost Sales and Backorders

If a store runs out of an item, the consumer will look elsewhere for the item and a sale is lost or an order will be placed for a unit of anticipated stock, a backorder. The lost sales situation is more likely to occur in a supermarket but can also occur in retailing. The backorder situation occurs almost exclusively in the retail industry. In either case, there is a loss of consumer goodwill which is not a measurable quantity. The backorder situation may cause additional paperwork but the lost

sales case causes lost revenue. Elimination of lost sales is, therefore, a goal of any sales organization. Even with the reduced safety levels, the POS System will reduce the likelihood of running out of stock.

d. B_{hi4} - Order and Holding Costs

Each item costs a certain amount to order in the sense that each procurement action costs money to accomplish. To hold an item in inventory costs money for record keeping and physical storage. Thus, there is a tradeoff between the two costs. To minimize holding costs, frequent orders would be placed. To minimize ordering costs, one order per year might be placed. Between the two extremes exists a point where the sum of these two costs is a minimum. With a reduction in the uncertainty associated with the POS System inventory, a reduction in the number of orders placed is feasible. Further, when an order is placed, the likelihood of overordering or mis-ordering is reduced.

f. B_{hi5} - Automatic Ordering

The POS System can provide a sophisticated closed loop inventory system. By a closed loop it is meant that orders are placed automatically, deliveries are entered in the system upon receipt and sales or issues are recorded as they occur, generating data that will facilitate the replenishment ordering. This benefit component is intended to address the automatic ordering aspect of the system. Receipt of delivery recording impact will be discussed in an ensuing component.

In order to deal with the generation of an automatic order by a POS System, an inventory strategy or model must be assumed. Three such models are; simple replenishment, replenishment

using forecasted requirements and order point replenishment. The use of a POS System will enhance any one of the three systems. Each one of the three is discussed briefly below with a comment concerning its support of automatic order generation;

(1) The simple replenishment strategy is simply ordering to replace that which is sold. Periodically, sales are reviewed and the number of units sold are replaced by reordering. This simplistic system is assisted by the fact that a POS System can provide the amount sold at any point in time.

(2) In the replenishment using forecasted requirements, the sophistication of the inventory system employed takes a quantum jump from simple replenishment. Forcasted requirements are those which are anticipated for some future period of time. Several forecasting techniques are discussed in appendix A. The forecast of future requirements is used to predict how much of an item will be sold between order placement and order receipt, a period called lead time. Thus, an order replenishes not only what was sold but also that which is expected to be sold. Since any forecast is based to some degree on past data, the POS aids this system by providing accuracy of information and precluding 'bad buys.'

(3) Order point replenishment establishes a level at which a reorder is triggered. In this system, the reorder point is based on the forecasting techniques discussed in appendix A. The reorder point encompasses safety stock and forecast sales during lead time and time between reviews. Here again, data-capture accuracy enhances the procurement accuracy and reduces erroneous dollar expenditures.

Utilizing one of the above systems to automatically generate orders will obviously reduce the personnel effort in this area but the inventory related benefit is the reduction of over and under stocking.

g. B_{hi6} - Receiving

Entry of receipt information at the receiving point provides instant asset visibility. The entries made at receipt can be quickly and accurately matched with order prices and quantity and records automatically adjusted. As a side benefit in this particular aspect is the currency and accuracy which can be injected into the company's accounts payable operation.

i. B_{hi7} - Shrinkage Analysis

Breakage, theft, spoilage, and waste all contribute to inventory shrinkage. If breakage, theft and waste are honestly reported, areas of unexplainable shortages will be reduced considerably. Isolation of shrinkage permits corrective action to be taken or investigative action to be initiated with the ensuing trimming of unprofitable losses.

3. Personnel $B_{hp} = \sum B_{hpi}$

Current labor costs alone make the review and analysis of any possible benefits or savings in this area imperative. In many ways, most benefits and savings that accrue to a POS System owner have personnel savings as a basis. To wit, the cost of taking inventory would drop in large part because fewer man-hours would be required. Thus, personnel savings can best be viewed in light of the number of personnel required to accomplish the particular aspect of the operation under review. It should also be remembered

in these reviews that the saving of a half man-day of effort is only a savings if that time can be effectively utilized elsewhere.

a. B_{hp1} - Terminal Operators. At full scanning operation, the decrease in check out or sales transaction time should be such that fewer ECR operators will be required. Admittedly, this benefit most easily applies to stores where checkout lines are grouped together. In retail stores with registers spread throughout the store, departmental registers are no longer necessary to segregate sales and with this flexibility, fewer registers and thus fewer people are required. One possible offset to these savings would be higher-priced register operators due to more sophisticated terminals. The programmed learning approach employable on ECR's should obviate this situation.

b. B_{hp2} - Price Marking

Almost exclusively, price marking labor savings apply to supermarkets with PLU capability. A reduction in price-marking personnel results not only from initial price-marking savings but from such re-marking, as is necessary.

c. B_{hp3} - Backroom Personnel

Those persons employed in a store whose jobs are not in the sales area can be described as working in the 'backroom.' These people include the sales data recorders, keypunch operators and accounting personnel. The quantity and quality of data captured by POS at the point of sale can eliminate the requirement to batch and record each days sales slips. It would no longer be necessary to keypunch data for input to the computer. The instantaneous entry of all pertinent data on receipts and sales can provide the accounting department with comprehensive financial

data at the push of button. Each of these th ree areas offer potential personnel savings reflected by the fact that a better job can be accomplished with fewer people.

B. SOFT BENEFITS $B_S = \sum B_{Si}$

The sum of soft benefits can be best expressed as a range of dollar values. For example, the amount of savings generated by a particular report to management might be $100 - $300, based upon what management did with the report [22]. A potential soft benefit may be of no benefit whatsoever if it is not brought to the attention of the appropriate management.

1. B_{S1} - Labor Scheduling

When are the peak traffic periods or in what departments do they occur? An answer to these questions can be obtained by conducting studies with observers and stopwatches. This is effective, but costly in time and money and the validity of the results will come into question in a short time [23]. With a POS System, the transaction loading is a dynamic measurement. The where and when of peak loading is available daily and can be utilized to predict future workload distribution. The peaks may be such that part-time help or schedule realignment is called for.

2. B_{S2} - Management Reports

Under a POS System, heretofore unavailable report data will be available to management. It is assumed that the data will have been meaningfully summarized for management use. The fact that new reports are available is important, but possibly even more important is the timeliness of the reports. Information available on a weekly or monthly basis is now made available daily or on a real-time basis. Sales analysis data will be available in such a

manner as to provide a buyer confronted by a salesperson enough current data to decide effectively on the wisdom of a procurement. Management can zero in on a suspected poor mover and make timely markdown decisions. The question of what sizes to buy in any given geographical area can be quickly answered by analysis of sales data concerning size and even color and style. If there is inventory shrinkage of any sort, remedial action can be initiated. Timely evaluation of advertising effectiveness in one day special sales can be accomplished. With a reduced workforce, it will be even more important than ever to insure that each person is performing up to standards, which can be more readily established on the basis of POS System data.

3. B_{S3} - Space or Shelf Allocation

In the dynamic atmosphere of today's selling, what and how much to put on the shelf is important. If two items have equal space allocated to them in the stores scheme of shelf allocation and one has a greater profitability, consideration should be given to increasing the shelf space of the more profitable item. With the availability of the computer, this type analysis can be accomplished on a store-wide basis by the host computer

As was noted in Chapter IV, all eventualities of a system cannot be set forth without knowledge of that particular system. Many cost and benefit areas have been discussed as a beginning to delineating systematically the costs and benefits associated with the acquisition of a POS System.

Utilization of the model will provide an initial cut at the decision to purchase;

$$Y(B_h + B_s) - (I_h + I_o + AY) = \$0.00$$

or equivalently

$$TB - TSC = \text{Lifetime excess of benefits over cost}$$

If the total benefits over the system lifetime exceed total costs, a recommendation to purchase is warranted. Appendix B provides an illustrative example.

VI. OTHER CONSIDERATIONS

While it is essential to conduct a hard dollar analysis of a potential acquisition such as a POS System, it is equally necessary that other less tangible considerations not be overlooked. It is important that the potential buyer stand back from the mire of dollar cost and benefit figures and look at the situation from different perspectives. Some of these peripheral factors that should be considered will be described in this chapter.

1. Consumer

With the exception of the POS System seller and buyer, no one has as much influence regarding system success as does the consumer. One of the supermarket POS System benefits is that each item need not be price marked [24]. The consumer has begun pushing for legislation against this omission of prices on the item contending that a price on the shelf only is not sufficient. If legislation of this sort is passed, the savings of not having to mark each item will be lost. Obviously, no grocer will continue a practice which is driving customers away even though it may save $4.50 per thousand items [25].

Most consumers have not come face to face with a computer terminal and the inherent apprehension concerning something new must be overcome. This can be done through education and by illustrating a tangible food cost drop. Of course, the food cost drop might be only a reduced rate of food cost inflation and not very visible to the average consumer.

The POS System can help the consumer by being faster primarily in the supermarket area. The consumer should have to wait less at the point of sale. After having been served, a more detailed record of the transaction will be provided to the customer. This is particularly true in the supermarket where the consumer has historically been handed a tape measuring several feet in length containing prices only. New grocery tapes can include in addition to the price charged, the UPC, whether the item is taxable, department (meat, produce, etc.), and price per pound and weight on variable weight items [26].

2. Operator

The operator will work with a machine which is quieter than most electro-mechanical registers. The ECR can be operated by key or, of course, input can be by scanning. Regardless, the operator has been considered in the design of the ECR as evidenced by the sequential programming transaction feature of some ECR's.

Due to entry audit features and the removal of the burden of tax calculation, cents off coupons and other similar potential error areas, the operator will be more accurate. Further, the operator's distasteful burden of credit checking or check cashing approval can be removed by inclusion of appropriate credit features. On the other hand, employee fears are beginning to rise concerning the POS System eliminating jobs. A Retail Clerks' International Association official fears a 25 to 30% loss of jobs. POS users claim that considerably less jobs will be lost and those by attrition [27].

3. Flexibility

Is the system being considered adequate to support your needs two years from now? What about four years in the future? Adequate capacity or the capability to expand the system in the future should be considered. The size of a small store chain could double in four years and the POS System should be planned accordingly. At this point in time, there is no set answer to what a POS System should look like or contain. It is an area of repidly changing technology that can find todays system obsolete tomorrow. Considerable care should be exercised regarding compatibility, convertibility and capability to expand because of this basically unsettled situation.

4. Source

Singer, NCR, IBM, Sweda International, Uni-Tote Division of General Instrument, National Semiconductor, Bunker Ramo ESIS Division and many more companies supply POS Systems. The company from which the system is purchased is of almost overriding importance. Since the system being procured is intended to last for some number of years, dealings with the supplier will not cease after delivery [28].

The supplier chosen should be financially stable in terms of long range commitments and be able to supply additional equipment in the future. In addition to financial stability, the supplier's maintenance capability is crucial. How many maintenance personnel are there? Where are they located? During what hours are they available and how long will it take them to get to the installation? What maintenance is under contract and what is not? The maintenance under a POS System should be no less than under an electro-mechanical

system. In fact, POS System maintenance may need to be better due to the fact that ECR's do not all possess stand-alone capability.

5. Regulation

Under the consumer section above, potential legislation concerning price marking was mentioned. At this point, it is still only a potential regulation or law. This may only be the first of such potential regulations to impact on POS technology. The Food and Drug Administration (FDA) has issued laser safety standards [29]. Although the type used in POS Systems are low powered and considered safe, the anticipated expanded usage of the laser will probably lead to FDA performance standards, safety features and warning labels.

The banking use of terminals is still being contested in the courts [30]. The ruling, discussed in the first chapter, that terminals do not constitute branch offices has been overturned by a U.S. District Judge. Judge Aubrey E. Robinson, Jr., stated that the terminals are branch offices and thus fall under federal banking laws. He did not, however, address the fate of the 150 terminals currently installed, choosing to rule on future installations only.

Potential regulation can impact heavily on a new system and it is well to consider the added costs that could occur.

6. Coding

The UPC has also been described as opening the door to unlimited productive capabilities. In fact, the adoption of UPC by the supermarket industry did provide a giant leap forward for Supermarket POS Systems. Adoption, acceptance and utilization of a standard coding could give similar impetus to the retail industry.

Until this is accomplished, coding options need to be kept open either by not going to scanning or adopting a coding which can be converted in the future.

7. Purchaser

Each segment of the purchaser's company should be in agreement on the concept and need for a POS System. Each division should be able, effectively and efficiently, to interface with the system and utilize the data output. The purchaser's potential for success in the undertaking will be enhanced considerably by the presence of personnel in the company with both systems analysis and software talents. The latter can define the system, produce software to run it and monitor and maintain it in the future.

In summary, there are many considerations that could be taken into account and the best approach to all of them is common business sense.

VII. OTHER AREAS FOR ANALYSIS AND CONCLUSIONS

As mentioned in the introduction, a more descriptive term than Point of Sale might have been Point of Transaction. An even more appropriate term might be distributive processing [31]. Distributive processing is the term used to describe source data processing, collecting data at or near its source. With the capability to effect extensive real-time editing becoming a reality, keypunch data entry will be significantly reduced in the future. This will not happen overnight but will evolve over time, since considerable disruption of traditional practices will occur. The view of POS as a data entry system is important, not only for the applications delineated in this thesis, but also for the application of distributive processing to other data collection and entry situations.

In the military, POS Systems have application now in the Commissaries, Exchanges and SERVMARTS. These areas are not the only data entry points that should be considered in the military. Application of the concept of distributive processing could seem to be unlimited in todays data-collection conscious world in both a military and civilian context.

As an indicator of the extent to which POS type technology can be applied, the OK Supermarket near Tokyo, Japan, can unequivocally state that its cashiers make no mistakes and shoplifting is non-existent. Each customer shops for merchandise displayed in individual glass cases. A desired item is obtained by inserting a specially coded plastic card in the display case and pushing a

button or two. An item is released from its case and the customers bill is incremented in the computer. Checkout is an instantaneous matter, merely the computer response to a request for the receipt. This store represents a current ultimate level in application but it may be doomed to the failure sustained by similar operations in Sweden and West Germany. Those two installations succumbed, at least in part, due to aesthetic pressure stemming from customers being unable to examine the glass-enclosed items.

Four specific POS related areas that would provide considerable material for future analysis became clear while this paper was being written:

1. An investigation of areas besides the SERVMART, in the Navy Supply Centers in which the application of POS principles and technology could enhance fleet support.
2. An investigation and analyses of the shipboard potential of POS Systems for inventory control.
3. An investigation and analysis of applications of simulation techniques to POS System evaluation, both prior to and after acquisition, could provide considerable assistance to decision makers.
4. An analysis of the specific impact of POS Systems in specific and distributive processing in general on inventory models extant today.

An approach to providing assistance to a decision-maker regarding POS System acquisition has been delineated. The approach was purposely general and non-technical. The intent was to promote a way to approach acquisition of a system which is basically too new to provide common knowledge of its own costs and benefits.

The conclusion that has to be drawn concerning POS System is that it is an expensive venture that can apparently provide a return on investment justifying its high cost. The caveat of this conclusion is that the system must be planned for, requirements delineated in detail and the system utilized to its fullest capacity as soon as feasible. The cost model presented in this thesis should be considered as a framework on which to build a customized analysis. Each installation is different and must be tailored to individual needs. When all hard analysis is concluded, the realities of the environment should be carefully considered before a final decision is made.

APPENDIX A

FORECASTED REQUIREMENTS

An accurate forecast is economically beneficial in that it helps insure that investment dollars are not wasted and that sufficient stock is on hand to meet customer demand. Four forecasting methods are described below:

1) Simple Averaging. All known demand is used in this method. The demands experienced over all time periods such as months or quarters are summed and divided by the number of time periods involved. Obviously, as more time is included, the prediction reacts to changes in demand less and less. Each time period is equally weighted in this method.

2) Moving Average. In the simple average method if twenty quarters demand history is available, it would be utilized for the forecast. The moving average method uses only some fixed number of recent time periods in its calculation, for example, the most recent eight quarters demand history. At each calculation, the oldest time period is replaced by the most recent. This method again applies equal weight to each time period and while being more adaptive, is still relatively slow to react to changes.

3) Weighted Moving Average. As the name indicates, this method is an expansion of the moving average method. The time periods considered are fixed, for example at eight quarters but the more current quarters demand is more heavily weighted in computing the forecast. This method can react more quickly to changes in demand.

4) Exponential Smoothing. This method is a refinement of the weighted moving average and retains the inherent swift reaction to change while minimizing the data and calculations to be performed.

Demand which is forecast for future periods is a prediction based on past demand observations. Utilizing a replenishment type model to generate orders necessitates predicting future requirements. The accuracy of a forecast depends on both the accuracy of the historic demand data utilized and the forecast method utilized.

The purpose of forecasting is to predict more accurately the demand that can be anticipated during procurement lead time. Since each method presented depends to some degree on historical demand data, it follows that more accurate data collection by POS Systems will generate more accurate forecasts.

APPENDIX B

POS SYSTEM COST-BENEFIT MODEL EXAMPLE

A small store example best illustrates the useful albeit simple nature of the model. The model example is based on a Weingarten grocery store pilot installation with a POS System (9 electronic cash registers) being considered as one alternative. The other alternative is an installation with 10 electromechanical registers (EMR). The price of an ECR is $3,000 while the electromechanical register costs $3,700. A ten year life of the system is anticipated (Y=10) and no soft benefits are included (B_S=0).

ITEM	POS/ECR	EMR	DIFFERENCE
I_h Hardware Investment			
I_{h1} Register	27,000	37,000	10,000
I_{h2} Controller	20,000	-	(20,000)
	$47,000	$37,000	$(10,000)
I_o-Other Investment			
I_{o1} Site Preparation	1,000	-	(1,000)
I_{o2} Backup Generator	3,000	-	(3,000)
	$4,000	-	$(4,000)
Subtotal	$51,000	$37,000	$(14,000)
A-Operating Costs			
A_1-Maintenance	4,000	1,000	(3,000)
A_2-Supplies	1,000	500	(500)
	$5,000	$1,500	$(3,500)
YA =	$50,000	$15,000	$(35,000)
TSC =	$101,000	$52,000	$(49,000)
B_h Hard Benefits			
B_{h1} Operator Salary Savings	8,000	0	8,000
B_{h2} Price-Marking Savings	6,000	0	6,000
	$14,000	0	$14,000

ITEM	POS/ECR	EMR	DIFFERENCE
$Y(B_h + B_s) = TB$	$140,000	0	$140,000
TB	140,000	0	
Less TSC	101,000	52,000	
Excess Benefits Over Cost	$39,000	$(52,000)	

The above example was simplified for purposes of illustration. An excess of benefits over costs results over the life span of the two systems only for the ECR installation. The EMR installation, while costing less, generates no benefits.

The model developed in this thesis was intended to provide an appropriate framework for discussion of POS Systems. With the inclusion of installation and environment particulars regarding depreciation, cost of capital, tax considerations and appropriate cost of capital, the modified model would provide more definitive support to acquisition decisions.

APPENDIX C

ABBREVIATIONS

ECR - Electronic Cash Register

EDP - Electronic Data Processing

EFT - Electronic Funds Transfer

EPOS - Electronic Point of Sale

IBM - International Business Machines

MIS - Management Information System

MODEM - Modulator - Demodulator

NCR - National Cash Register

NRMA - National Retail Merchants Association

NSC - Naval Supply Center

NRSO - Navy Resale System Office

OCR - Optical Character Recognition

POS - Point of Sale

PLU - Price Look Up

UPC - Universal Product Cope

VRIS - Voluntary Retail Identification Standard

LIST OF REFERENCES

1. Shapiro, Moses, "The POS Revolution is Now," Stores, p. 16, January 1974.

2. LaFianza, B. J. and Stewart Edmund, "Navy Resale System Joins the Supermarket Revolution," Navy Supply Corps Newsletter, v. 38, p. 18, January - February 1975.

3. Pease, Daviol, "Terminals Offer Versatility," Data Management, p. 9, July 1974.

4. "Grocery Store Computers Let Customers Bank There," Wall Street Journal, p. 18, 21 January 1974.

5. "New Bank Ruling May Put You Next to the Bologna," Wall Street Journal, p. 20, 13 December 1974.

6. Walker, Gerald M., "Supermarket Sales Begin to Pile Up," Electronics, p. 70, 30 May 1974.

7. "A Costly Fling," Forbes, p. 36, 15 December 1973.

8. Myers, Edith, "Space Leaves POS Market," Datamation, v. 19, p. 101-102, December 1973.

9. Zimmerman, Robert M., "Retailers Look Beyond POS to Meet Information Needs," The Data Communication User, p. 33, December 1974.

10. "UPC Moving Faster Than Expected," Datamation, p. 111, November 1974.

11. "Voluntary Retail Identification," Stores, p. 2, December 1974.

12. IBM Report No. GA27-3076-1, IBM 3660 Supermarket System Introduction, October 1973.

13. Naval Supply Center Charleston, South Carolina, Electronic Point of Sale System Evaluation, 9 May 1975.

14. Naval Postgraduate School Report Number NPS55RH73061A, Analytical Models for SERVMART Inventory Control, by F. R. Richards and LCDR L. R. Atkinson, SC, USN, June 1973.

15. Guide to Retail Point of Sale Systems, 2nd ed., p. 11, Auerbach Publishers Inc., 1974.

16. "How Giant Sears Grows and Grows," Business Week, (Reprint), 16 December 1972.

17. "Universal Produce Code Creates Retail Data Management Revolution," Data Management, p. 24-29, August 1975.

18. Rubner, Hans J., "The Impact of Point of Sale," Stores, v. 56, p. 2, August 1974.

19. "Supermarket Trims Bad Check Losses via On-Line Authorization," Data Communications User, p. 41, July 1975.

20. "Weingarten Adds Up the Savings," Progressive Grocer, p. 60, August 1974.

21. Hadley, G. and Whitin, R. M., Analysis of Inventory Systems, 1st ed., Prentice Hall Inc., 1963.

22. Wagner, Michael, "Chain Study Details Scanner Costs, Benefits," Supermarket News, v. 24, No. 17, p. 1, 28 Spril 1975.

23. Supermarket System: Manpower Management Concepts, 1st ed, September 1973.

24. "Things Look Good for POS in 75," Datamation, p. 113, April 1975.

25. Myers, Edith, 'Supermarkets Seek Systems Solution to Profit Squeeze," Datamation, v. 18, p. 142, November 1972.

26. Dickens, Robert Lee, "Tomorrow's Retail Checkout Counter - You Just May Not Recognize It," Advertising Age, 2 July 1973.

27. "Supermarket Computers," Wall Street Journal, p. 1, 14 January 1975.

28. Solomon, Irving I., "Electronic 'Point of Sale,'" Stores, p. 26, February 1974.

29. "FDA Issues Safety Standards for Lasers," Monterey Peninsula Herald, p. 21, 29 July 1975.

30. "Judge Rules on Terminals," Monterey Peninsula Herald, 1 August 1975.

31. W. Harry Vickers, "Focus on Data Entry Terminals," The Data Communications User, p. 28, July 1975

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Documentation Center Cameron Station Alexandria, Virginia 22314	2
2.	Library Code 0212 Naval Postgraduate School Monterey, California 93940	2
3.	Department Chairman, Code 55So Department of Operations Research and Administrative Sciences Naval Postgraduate School Monterey, California 93940	2
4.	Asst Professor F. R. Richards, Code 55Rh Department of Operations Research and Administrative Sciences Naval Postgraduate School Monterey, California 93940	1
5.	LTJG G. G. Brown, Code 55Zr Department of Operations Research and Administrative Sciences Naval Postgraduate School Monterey, California 93940	1
6.	Mr. Robert Trocle Navy Resale System Office 3rd Avenue and 29th Street P. O. Drawer 12 Brooklyn, New York 11232	1
7.	Mr. S. S. Lee, Code 60A Naval Supply Center Charleston, South Carolina 29408	1
8.	LCDR J. A. Fleming, Jr., SC, USN U.S.S. California (CGN-36) Fleet Post Office New York, New York 09501	3
9.	Defense Logistics Studies Information Exchange Fort Lee, Virginia 23801	1